

## PhD position on Topology Optimization for large-scale systems using HPC

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Company: KU Leuven

Location: Leuven

Category: computer-and-mathematical

Candidates must hold a master's degree in Applied Mathematics or in Mathematical Engineering. Candidates should have a good background in numerical computing with the finite element method and numerical optimisation. They should have experience with scientific programming in Python/C++ and the will to use it as a daily research tool, as well as a taste for mathematical rigor. Proficiency in English is required, as well as good communication skills, both oral and written. The position adheres to the European policy of balanced ethnicity, age and gender. Persons of all origins and gender are encouraged to apply.

**BACKGROUND** Topology Optimization (TO) is a powerful technology which allows to compute optimized designs of physical systems in a fully automated manner, without any assumed parameterization of the geometry. From the mathematical standpoint, it consists of solving nonlinear optimization problems constrained by partial differential equations. This technology allows to improve the performance in various physical settings such as structural design, heat exchangers, or nanophotonic crystals. Nowadays, there is a growing industry demand for applying these methods to large scale three-dimensional systems, which is challenging due to the need for high computational resources. There is therefore the need for developing dedicated algorithms leveraging High Performance Computing methods, namely distributed computing on multiple CPUs or GPUs.

### PHD PROJECT DESCRIPTION

The research aims at developing an efficient computational platform for three-dimensional Topology Optimization of large-scale multiphysics systems.

The research will first aim at bringing several improvements to the Null Space Optimization

algorithm developed for Topology Optimization (<https://null-space-optimizer.readthedocs.io/en/latest/>) such as integrating LBFGS acceleration and efficient preconditioners for the quadratic programming solver identifying the descent direction. A second part of the work will consist in searching for and integrating efficient parallel remeshing methodologies for body-fitted shape updates (see e.g. Feppon, et. al., Topology optimization of thermal fluid-structure systems using body-fitted meshes and parallel computing). These methods will be applied on several physical systems such as heat transfer devices and stress-constrained designs. The PhD position is supervised by Prof. F. Feppon (Numerical Analysis and Applied Mathematics Section, NUMA, Department of Computer Science) and co-supervised by Prof. Panos Patrinos (Department of Electrical Engineering, ESAT) at KU Leuven. At the Department of Computer Science of KU Leuven, the NUMA research unit works on numerical methods, algorithms and software for simulation and data analysis, with applications in many fields in science and engineering. The research in NUMA focuses, amongst others, on numerical simulation, optimization and high performance computing. The PhD position lasts for the duration of four years, and is carried out at the University of KU Leuven. The candidate also takes up a limited amount (approx. 10% of the time) of teaching activities. The remuneration is generous and is in line with the standard KU Leuven rates. It consists of a net monthly salary of about 2400 Euro (in case of dependent children or spouse, the amount can be somewhat higher); social security is also included. Following Belgian law, the salary is automatically adjusted for inflation based on the smoothed health index.

The candidate will be encouraged to present his/her work at international conferences and will be covered by a dedicated travel funding.

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